Using Rotational Thrombolelastomety to Guide Blood Resuscitation: Potentially Improving patient Outcomes While Decreasing Overall Hospital Costs

DNP Final Project

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By

Danielle Teresa Scharpf, MSN, CRNA

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DNP Project Committee:

Gerene S. Bauldoff, PhD, RN, FAAN, Advisor

Kristine Browning, PhD, CPN

Michelle Weber, DNP, CNS-BC

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Dedication

I dedicate this project to my incredible family, friends, and boyfriend. Thank you for all of your unwavering support, understanding, and love. I am incredibly blessed to have so many amazing people in my life. Thank you for being my cheerleaders and rocks. I could not do any of this without all of you. I would also like to dedicate this project to my Guardian Angel, my Mom. Thank you for being my guide from above, and for teaching me that the sky isn't the limit, and that I truly can accomplish anything I put my heart into.

Abstract

Background: Hospitals are being forced with the task of finding new ways to provide the same high level of care at a lower cost. One possible way of accomplishing this task is through the use of Rotational Thrombolelastomety (RoTEM®), as a way to guide blood resuscitation in order to decrease patient exposure to blood products while decreasing overall hospital costs at the Ohio State University Wexner Medical Center.

Methods: Utilization of the OSUWMC's liver transplant quality database allowed for comparison of the RoTEM® group to the standard method for intra-operative and 24hr post-operative blood product usage and its cost for patients that underwent surgery from July 2012 to July 30, 2014 at OSUWMC. It also evaluated post-op surgical intervention requirements for bleeding.

Results: There was an average 34.78% reduction in intra-operative blood product usage with an average 19.4% cost reduction when utilizing the RoTEM®. There was a decrease in pRBC product usage during the first 24hr post-op with an average cost reduction of 49.25% in the RoTEM® group. Lastly, there was a 66.67% reduction in post-op surgical intervention when utilizing the RoTEM®.

Conclusion: Positive trends can been seen in both decreased blood product exposure to patients and overall cost reductions for the hospital. More projects need to be done in the future.

Chapter I: Introduction

Introduction

In the current United States healthcare economy medical institutions and providers are challenged with the task of providing high quality care at lower costs. Providers need to find ways to use technology in order to work smarter and not harder. One way of accomplishing this task is through the usage of Rotational Thrombolelastomety (RoTEM®). The RoTEM® is a point-of-care testing device that aids anesthesia providers in differentiating between surgical bleeding and underlying patient coagulopathies (Health Policy Advisory Committee on Technology, 2012, p. 2, Kozek-Langenecker, 2005). This project demonstrates how the usage of the RoTEM® can aid providers in blood product administration, allowing them to decrease overall blood product usage.

Problem

Many times patients receive more blood products than necessary during surgery because anesthesia providers lack a quick way to determine the patient's underlying coagulation or bleeding issue. Traditionally the inability to differentiate between patient coagulopathies verses surgical bleeding results in transfusing multiple blood products continuously until the underlying issue becomes more apparent. When administering more blood products than necessary, patients are placed at higher risk for developing complications. Listed in (Table 1) are some examples of early and late complications that can occur after blood product transfusion (Maxwell & Wilson, 2006, p.225).

Table 1: Complications of Blood Transfusion (Maxwell & Wilson, 2006, p. 225)

Early
- Haemolytic reactions
  - Immediate
  - Delayed
- Non-heamolytic febrile reactions
- Allergic reactions to proteins, IgA
- Transfusion-related acute lung injury
- Reactions secondary to bacterial contamination
- Circulatory overload
- Air embolism
- Thrombophlebitis
- Hyperkalemia
- Citrate toxicity
- Hypothermia
- Clotting abnormalities (after massive transfusion)

Late
- Tranmission of infection
  - Viral (hepatitis A, B, C, HIV, CMV)
  - Bacterial (*Treponeum pallidum*, *Salmonella*)
  - Parasites (malaria, toxoplasma)
- Graft vs. host disease
- Iron overload (after chronic transfusions)
- Immune sensitization (Rhesus D antigen)

Currently, blood resuscitation of patients is guided by the clinical judgment of the anesthesia provider and standard coagulation tests such as activated partial thromboplastin time (aPTT), prothrombin time (PT), and international normalized ratio (INR) (Health Policy Advisory Committee on Technology, 2012, p. 9, Song, Jeong, Jun, Lee, & Hwang, 2014). This type of management lags standardization in the amount, and type of blood products given to a patient, and lacks the ability to provide real-time care. Standard coagulation tests take approximately 60-90 minutes to yield results and are unable to identify singular or multiple coagulation deficiencies, assess for rapid fibrinolysis, evaluate platelet dysfunction, or differentiate hemostatic response to tissue injury or surgery (Health Policy Advisory Committee on Technology, 2012, p. 9).

Increased transfusion by anesthesia providers during the intraoperative period is a concern in the overall quality of care of the perioperative patient. Blood transfusions during liver transplant surgery have been associated with higher rates of infection, prolonged stay in intensive care units, immunologic effects on graft rejection, and increased patient mortality (Devi, 2009, Jabbour , et al., 2005; Hendriks, et al., 2001).

Increased transfusion rates are also very costly to both the patient and hospital. Toner, et al., (2011), state after their cross-sectional randomized study (n=204), the cost for one unit of pack red blood cells was $210.74±37.9 US dollars and the average charge to the patient (n=167) was $346.63± 135 U.S. dollars (Toner et al., 2011, p. 36). In this study there was statistical significance ($p<0.0001$) of acquisition of cost by different regions within the United States, as well as discounted rates to large teaching hospitals (Toner et al., 2011, p. 36). At The Ohio State University Wexner Medical Center (OSUWMC), the cost of one unit of pack red blood cells is $217.14, fresh frozen plasma is $39.87, a four pack of pooled platelets is $475.98, and a pack of cryoprecipitate is $335.33(OSU Wexner Medical Center Transfusion Services, 2014). This cost is expected to increase due to the decline in blood donors. The American Red Cross reports that due to the extensive screening process of donors for risk factors such as: travel, medication use, disease, and high-risk behaviors, it is estimated that only 38% of the United States population are eligible to donate blood, and less than 10% of people eligible actually donate blood (American Red Cross, 2014). Transfusion of blood products has also been linked to increased length of stay in intensive care units, increased overall hospital stay time, and increases in overall hospital costs. (Murphy, et al., 2007).

Purpose

The purpose of this project is to examine the usage of Rotational Thrombolelastomety (RoTEM®) to guide blood resuscitation as a potential area to decrease patient exposure to blood products while decreasing overall hospital costs in the liver transplant program at the Ohio State University Wexner Medical Center.

Significance to Nursing, Healthcare, and the DNP Essentials

Nursing, as well as many other healthcare specialties, are always looking for ways to improve patient outcomes. The RoTEM® produces quick, easily interpreted results that provide anesthesia providers with information on the patients underlying coagulation issues. This information then allows providers to make better clinical judgments in order to provide individualized goal-directed blood resuscitation, giving the patient only the blood products that he/she requires. This will help reduce the incidence of transfusion which can lead to complications and undesired patient outcomes.

In today's healthcare economy providers are forced to find new ways to decease overall costs while still providing high quality care. The RoTEM® allows for this high quality individualized care while also decreasing overall costs.

The eight DNP essentials are: (1) understanding scientific underpinnings for practice, (2) being a leader in organizational and system improvements in order to advance thinking, (3) using clinical scholarship and analytical methods in evidenced based practice, (4) using information systems and technology for the improvement and transformation of care, (5) being a leader in healthcare advocacy and policy making, (6) being an integral part in interprofessional collaboration for improving patient and population health , (7) being an active participant in population health in order to improve overall nations' health, and (8) to be a leader in advancing the nursing profession (Zaccagnini & White, 2011). The RoTEM® allows for the use of new technology to transform care in order to advance thinking in the healthcare system. It also helps advance the nurse anesthesia profession by providing clinicians with more timely and specific data that assists in making faster and more informed decisions in the management of their patients care.

PICO Question

In the perioperative patient [P], does the use of Rotational Thrombolelastomety (RoTEM) for guiding blood resuscitation [I] compared to the standard method [C], impact the overall amount of blood products given to the patient.[O]?

Project Objectives

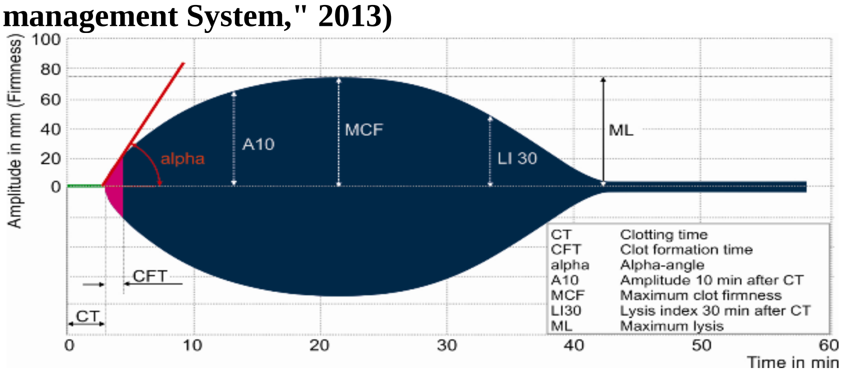
- Illustrate that the use of Rotational Thrombolelastomety (RoTEM®) to guide blood resuscitation as a potential area to decrease patient exposure to blood products.
- Examine the amount of blood products given to patients during the intraoperative period and 24hr post-op period in liver transplant patients before and after implementation of the RoTEM®
- Examine the cost of the blood products given to the patient during the intraoperative period.

Chapter II: Review of the Literature

The RoTEM® is a device that evaluates a sample of whole blood and measures the viscoelastic properties during multiple aspects of blood coagulation (Health Policy Advisory Committee on Technology, 2012, p. 1). It provides information to the healthcare provider on the cause of the patient's bleeding. It determines the clotting time, the dynamics of the blood clot formation, clot stability and lysis, speed of initial fibrin formation, and the influence of clotting factors and anticoagulants; providing an individualized differential diagnosis of coagulopathies (Health Policy Advisory Committee on Technology, 2012, p. 2, Kozek-Langenecker, 2005). The RoTEM® is a mobile unit that can be transported easily and can provide results in 10-20 minutes and preliminary results can be visualized within two minutes of starting the test (Health Policy Advisory Committee on Technology, 2012, p. 3). Analysis of blood samples can be re-evaluated 10 minutes after the administration of more blood products or coagulation factors, allowing for individualized goal-directed therapy (Gorlinger, et al., 2007). Rugeri et al. (2007) found that the RoTEM® parameters correlated with current standard coagulation parameters and platelet counts (Rugeri et al., 2007). This study also found that the RoTEM® was able to detect changes of *in vivo* coagulation issues within 10 minutes of running a sample, further supporting its usefulness as a point of care system (Rugeri et al., 2007). This device is simple to use and can quickly distinguish between surgical bleeding and bleeding caused by coagulopathies (Health Policy Advisory Committee on Technology, 2012, p. 9).

When using the RoTEM®, five predefined tests, the INTEM (ellagic acid activated intrinsic pathway), EXTEM (tissue factor triggered extrinsic pathway), HEPTEM (ellagic acid activated intrinsic pathway plus heparinase), APTEM (tissue factor activation plus aprotinin), and FIBTEM (with platelet inhibitor (cytochalasin D) evaluating the contribution of fibrinogen to clot formation) are used (Theusinger, et al., 2010, "ROTEM: The bleeding management System," 2013). These predefined tests differ from standard coagulation tests of fibrinogen, prothrombin time, and activated partial thromboplastin time because they are performed on whole blood rather than plasma, and it measures the process involving thrombin generation, clot formation, and lysis. Standard tests only look at the processes leading up to the initial generation of thrombin (Theusinger et al., 2010). Within the predefined tests there are several parameters used to describe the dynamics of the blood clot (Health Policy Advisory Committee on Technology, 2012, Theusinger, et al., 2010, "ROTEM: The bleeding management System," 2013). Clotting time (CT) is from the start of the analysis until the start of the clot formation. Clot formation time (CFT), or the period that it takes until amplitude of 20mm (firmness) is reached (Theusinger et al., 2010). The alpha angle is the angle between the center line and a tangent to the curve through the 2-mm amplitude point (Theusinger et al., 2010). A10 and A20 are the amplitudes 10 and 20 minutes after clotting time. MCF is the maximum amplitude of the curve or maximum clot firmness (Theusinger et al., 201). ML represents the maximum fibrinolysis detected during the measurement and LI30 and LI60 represent lysis indexes 30 and 60minutes after the clotting time (Theusinger, et al., 2010, "ROTEM: The bleeding management System," 2013).

Figure 1: RoTEM reactive curve and coagulation parameters ("ROTEM: The bleeding management System," 2013)



In 2011, and again in 2013, the Cochrane Collaboration published a qualitative review on the use of Thrombelastography (TEG) or thromboelastometry (ROTEM®) to guide blood resuscitation in patients undergoing massive blood transfusion (Afshari, Wikkelso, Brok, Molier, & Westlerslv, 2011). In this review 2560 articles were examined pertaining to the use of the TEG and or RoTEM® and 2537 were excluded due to their irrelevance, bias, duplication of other studies, and incompleteness of data (Afshari et al., 2011). Twelve additional articles and two trials were further excluded due to no preliminary results, leaving a total of 9 studies to be evaluated (Afshari et al., 2011). Data from the nine relevant studies were compiled and yielded an overall sample size of 776 patients (Afshari et al., 2011). To combine the studies a Chi test with a $P \leq 0.1$ was considered significant to provide an indication of heterogeneity between studies (Afshari et al., 2011, p. 12). These studies showed that the use of the RoTEM® decreased the amount of overall mortality (9/238 deaths in the TEG/RoTEM® group, compared to 12/235 in the control group), but this rate was unfortunately not statistically significant (Afshari et al., 2011, p. 18). The review found statistical significance though in a reduction of the overall amount of post-operative bleeding of patients in TEG/RoTEM® group verse the control group, and a reduction in the total amount of blood products needed in patients receiving both Fresh Frozen Plasma (FFP) and platelets (Afshari et al., 2011, p. 18). The overall conclusion of the review was that more controlled studies with minimal bias are required to further evaluate the benefits for the usage of the RoTEM® (Afshari et al., 2011).

The American Society of Anesthesiologists (2015) recently added the use of the RoTEM® to their practice guidelines for perioperative blood management after the organizations qualitative literature review (American Society of Anesthesiologists, 2015, p. 243). The ASA suggest the use of point-of care testing such as the RoTEM®, to identify areas where interventions can be employed (ASA, 2015). In order to evaluate the literature the ASA placed the evidence into different levels of scientific evidence. To be considered category A evidence, their highest category, randomized control trials had comparative findings between clinical interventions for specified outcomes (ASA, 2015). Statically significant ($P<0.01$) outcomes were designated as either beneficial(B) or harmful(H) to the patient; or statistically nonsignificant evidence was designated as equivocal(E) (ASA, 2015,p.243). This category is then broken down into two levels that refer to the strength and quality of the literatures evidence (ASA, 2015). Level 1 was literature that contained a sufficient number of randomized control trials to conduct meta-analysis, and a level 2 was literature that contained multiple randomized control trails but the number of randomized control trails was not sufficient to conduct a variable meta-analysis (ASA, 2015,p.243). In these guidelines the ASA found category A2-E evidence that there are variable findings regarding blood and blood product usage with the usage of protocols and algorithms (ASA, 2015). Category A2-B evidence was found in that there are reduced blood transfusions with TEG-guided protocols/ algorithms in cardiac surgery patients (ASA, 2015). Lastly, category A1-B evidence was found in the reduction in allogenic blood product requirements with the usage of a RoTEM® algorithm in burn patients (ASA, 2015).

Gorlinger, et al. (2011), reported in a retrospective study of a university hospital (n= 3,865), a 50% reduction in the incidence of massive transfusion (1.3% verse 2.5%, p= 0.006), as well as a decrease in the need for surgical re-exploration post-operatively (2.2% verse 4.2%, p=0.0007) after implementation of the RoTEM® as a point-of-care system (Gorlinger, Dirkman, & Et al, 2011). Anderson and colleagues (2006) further support these finding through their clinical audit of a cardiac intensive care unit, where they found significantly fewer amounts of patients requiring blood products after the implementation of the RoTEM® as a point-of-care system (Anderson, et al., 2006).

Song and colleagues (2014) support the use of the RoTEM® through their retrospective single institutional study of liver transplant patients (n=236), who typically have massive bleeding (Song et al., 2014). This study showed (86% sensitivity and: 77% specificity) of current lab parameters correlating with the RoTEM® parameters (Song et al., 2014). It wasalso concluded that the RoTEM® had more rapid results and was able to predict thrombocytopenia and hypofibrinogenaemia in this specific patient population (Song, et al., 2014).

When looking at the financial aspects of RoTEM®, the costs to run the tests are comparable to the standard lab tests that are done currently. Also due to the devices simplicity the RoTEM® requires no advanced training or skill to perform (Health Policy Advisory Committee on Technology, 2012, p. 10). See Table 2 for cost analysis. In addition to the cost of performing the test, the price for maintenance agreements for the RoTEM is $3,190.00 per year. Although, when factoring in this cost, keep in mind that many hospitals don't account for the maintenance of their standard lab machines and storage when evaluating their budgets ("ROTEM: The bleeding management System," 2013). Many hospitals have found an overall cost savings when using the RoTEM. Gorlierger and colleagues (2008) reported an overall cost savings of 35% (Gorlinger, et al., 2008), and Spalding and Harturmpf (2007), reported an overall cost savings of 44% after implementation of the use of the RoTEM. Hass and colleagues (2014) also reported a 17.1% mean total cost per patient decrease after implantation of the RoTEM (Haas, Goobie, Spielmann, Weiss, & Schmugge, 2014).

Table 2: Cost Analysis of the RoTEM verse current standard tests (Health Policy Advisory Committee on Technology, 2012, p. 11) *** HEPTEM only needs to be run if the patient was anticoagulated with heparin.*

Item	ROTEM delta	Standard Laboratory Tests
Equipment	$37,000	na
Cost of tests*	EXTEM – $13.40 INTEM - $13.40 FIBTEM - $16.77 HEPTEM - $17.08 APTEM - $19.45 *(costs inclusive of ROTEM pin, pipettes and reagents required)	aPTT – $10.69 PT – $10.69 Platelet count – $15.95 Fibrinogen - $44.58
Total costs/ Set of tests	$80.10	$81.91
Maintenance Agreements	ROTEM - $3190.00/year	na

Legend: EXTEM= Tissue factor activation via extrinsic pathway; aPTT=activated partial thromboplastin time; INTEM= ellagic acid activated intrinsic pathway; PT=prothrombin time; FIBTEM= tissue factor activation plus platelet inhibition; HEPTEM= contact activation with heparinase; APTEM= EXTEM based assay in which fibrinolysis is inhibited by aprotinin in the reagent

Chapter III: Methods

Project Design:

This quality process project used a retrospective de-identified case review of liver transplant surgical cases at the Ohio State University Wexner Medical Center's (OSUWMC) Perioperative Unit from July 2012 to July 30, 2014.

Sample:

A convenience sample of human patients that underwent liver transplant surgery from July 2012 to July 30, 2014 at OSUWMC was examined. This patient population was chosen because they typically yield massive blood losses and require large amounts of blood products during the perioperative period (Alkozai, Lisman, & Porte, 2009). Also this patient population has utilized the RoTEM® for transfusion resuscitation during the intraoperative period within OSUWMC.

Methods

Approval from the OSUWMC Clinical Affairs and Patient Safety department was obtained and the project was designated a Quality Improvement project. Since the project was declared a quality improvement project, the IRB ruled the project IRB exempt.

This quality process project used the liver transplant department's quality database to examine blood product utilization. The database was examined after all patient identifiers were removed. Liver transplant cases from July 2012 to July 30, 2014 were included and placed into two categories; cases that utilized the RoTEM® and cases that did not.

In order to assess patient's acuity level and degree of severity of liver disease between the two groups, each case was assessed for a model for end-stage liver disease (MELD) score. This score assesses the three parameters of serum bilirubin, INR, and serum creatinine, and has been adopted by the United Network of Organ Sharing in the United States as the gold standard in order to prioritize patients for donor transplant (Kaufman & Roccaforte, 2001). It has been reported in the literature that a MELD scores can be a predictor for three month non-operative mortality (Wiesner et al., 2003, p. 91). See table 3.

Table 3: MELD Score Coorlation With Three Month Non-Operative Mortality

	MELD SCORE				
	<9	10-19	20-29	30-39	>40
3 Month Non-Operative Mortality	1.9%	6%	19.6%	60.2%	79.3%

After the MELD score was evaluated the type and number of blood products received during the intraoperative period was recorded. These blood products included the number of pack red blood cells (pRBC), fresh frozen plasma (FFP), platelets (pLT), and cryoprecipitate (cryo). The total number of pRBC given in the first 24hrs post-op was also evaluated. In addition to this, the total cost of blood products per case were calculated using the OSU Wexner Medical Center's institutional costs per product.

It was anticipated that ROTEM use to guide blood product resuscitation therapy will show an overall decrease in the amount of blood products that a patient receives. This quality project will demonstrate to the organization a potential area for future research in overall cost reductions for the institution while increasing patient outcomes.

All information was stored in a password protected electronic file with access by only those directly assisting in the project, and de-identified data files were maintained by the advisor according to IRB requirements in a locked cabinet in a locked office.

Data Analysis

An Excel spreadsheet was created to store unidentified information. This allowed for percentile comparison between the RoTEM and non-RoTEM groups. The data was used to describe cost reduction and reduction of patient blood product exposure. Intra-operative blood product reduction trends were calculated with an excel algorithm that looked at the total amount of individual blood products given during each of the 53 cases and compared these totals between the two groups. To assess intra-operative cost reduction trends, the cost that The Ohio State University Wexner Medical Center (OSUWMC) pays for each blood product was used. The cost of one unit of pack red blood cells (pRBC) is $217.14, fresh frozen plasma (FFP) is $39.87, a four pack of pooled platelets is $475.98, and a pack of cryoprecipitate (cryo) is $335.33(OSU Wexner Medical Center Transfusion Services, 2014). The total number of products used for each patient for each blood product (pRBC, FFP, platelets, and cryo) was multiplied by the product's individual cost. The total cost of all the products given per each of the 53 cases was then computed. These totals where then averaged between the two groups and compared. The 24hr post-surgery pRBC usage was calculated by evaluating the number of pRBCs each patient received in the 24hours post-surgery. The mean was calculated and then compared between the two groups. The 24hr pRBC cost was calculated by once again evaluating the number of pRBC given to each patient and multiplying it by the cost to the institution for one unit ($217.14). The average cost was calculated for each group and then compared.

To evaluate the data for statistical significance a comparison T-test was performed. In addition to this, a Mann Whitney U non parametric test was performed to compare the summation of ranks between the two groups. Since readmission to the operating room for surgical intervention is nominal data a Chi square and Cramer's V comparison test was calculated.

Chapter IV: Findings

Results

Description of the Sample

During the time period from July 1, 2012 to July 30, 2014 at the OSUWMC a total of 53 patients underwent liver transplant surgery. Among these patients the RoTEM® was used on twenty-five patients, twenty-eight patients were in the comparison group. An average MELD score of 24.6 was found in both groups.

Average Blood Product Usage

The non-RoTEM® group had an average of 20 total units of intraoperative products that were given, while the RoTEM® group had an average of 13 total units given during the intraoperative period; a 34.78% reduction in intraoperative product usage per case when utilizing the RoTEM®. There was an average of 5 less units of FFP given per case in the RoTEM® group; a 50.1% reduction. Every category except cryoprecipitate had a reduction in the amount of products given in the RoTEM® group. See Table 4.

Table 4: Descriptive comparison for Intraoperative Product Usage:

Product	Number	Average pRBC Used (units)	Average FFP Used (units)	Average PLT Used (units)	Average Cryo Used (units)	Average Total Blood Product Used (units)
RoTem® Used						
No	28	5.78	10.42	2.53	1.42	20.18
Yes	25	3.96	5.20	2.10	1.88	13.16
	Difference in Usage	**1.82**	**5.22**	**0.43**	**-0.46**	**7.02**
	Percentage Difference	**31.5%**	**50.1%**	**16.9%**	**-32.4%**	**34.78%**

Average Hospital Costs for Intraoperative Product Administration

In the Non- RoTEM® group the average hospital cost for intra-operative product usage was $3,358.09, while the average cost in the RoTEM® group was $2,706.70. This is a difference of $651.39 or 19.4% between the two groups. Table 5 describes the findings from this process.

Table 5: Description of the Average Hospital Costs for Administered Intraoperative Product

RoTEM® Used	Cases Analyzed	Average Hospital Cost
No	28	$3,358.09
Yes	25	$2,706.70
	Difference in Cost	**$651.39**
	Percentage Difference	**19.40%**

Average 24hr Post Surgery pRBC Usage and its Cost to the Hospital

In the Non- RoTEM® group patients received an average of 3.07 units of pRBCs in the 24hrs immediately following surgery, while the RoTEM® group received an average of 1.56 units of pRBCs. Fourteen of the 25 patients in the RoTEM® group required no pRBCs 24hrs post-op.

Using the OSUWMC's institutional cost for one unit of pRBCs ($217.14), the average charge to the Medical Center for 24hr post-operative transfusion in the non- RoTEM® group is $667.50 compared to the $338.74 charge in the RoTEM® group. This is a $328.77 or 49.25% difference in cost between the two groups. Table 6 describes these differences.

Table 6: Average 24hr Post Surgery pRBC usage and Hospital Costs

RoTEM® Used	Cases Analyzed	Average 24hr post pRBCs Units	Average 24hr Post pRBC Cost
No	28	3.07	$667.50
Yes	25	1.56	$338.74
	Difference	**1.51**	**$328.77**
	Percentage Difference		**49.25%**

Readmission to the Operating Room for Bleeding

The cases were then evaluated for post-operative bleeding that required surgical intervention. In the non- RoTEM® group six patients had to return to the OR, while only two had to return in the RoTEM® group. This is a 66.67% reduction in post-operative surgical intervention for bleeding. See Table 7.

Table 7: Description of the Readmission to the Operating Room for Bleeding

RoTEM® Used	Cases Analyzed	Readmission to the OR for Bleeding
No	28	6
Yes	25	2
	Difference	**4**
	Percentage Difference	**66.67%**

Statistical Significance

After performing a comparison T-test, and a Mann-Whitney U test, none of the findings were statistically significant because of the low sample size and decreased power. This makes it impossible to either accept or reject the hypothesis.

Financial Impact of the Device

According to Tem Innovations GmbH, the inventors and distributers of the RoTEM® machine, the cost to purchase a device is $59,000, and typically has an estimated useful life of 5-10 years (Tem Innovations GmbH , 2015). After examining the liver transplant population in this project, the results indicate an average total cost savings of $990.13 per case. This breaks down to an average of $651.39 savings per case in intra-operative blood products and an average of $338.74 savings in blood product usage 24-hours post-operatively. Accordingly, this would require 60 cases to be performed to cover the original purchase price of the machine. In the tested population, if thirty cases are completed per year, the original purchase price of the machine would be covered within the first two years of operation, which provides an additional 3-7 years of useful life still remaining for future savings to the hospital.

Chapter V

Discussion

Although, none of the calculated values were statistically significant there are some promising trends that should be noted from this population and project. First is the actual cost and efficiency of performing the actual point-of-care test with the RoTEM®. It is $1.81-$18.89 cheaper, depending if a HEPTEM needs to be performed, when using the RoTEM® verses the standard method (Health Policy Advisory Committee on Technology, 2012, p. 11). Also with the RoTEM® an anesthesia provider can obtain lab results within 2-10 minutes, verses an hour with the standard technique (Song,et al., 2014). These quick results are extremely important in this population since their condition can change very rapidly making it almost impossible to have the same conditions an hour after sending labs. Thus, the RoTEM® allows a cheaper and quicker way to provide individualized care.

The results of this project are also consistent with previously discussed studies, showing a decrease in overall blood products given to patients both intra-operatively and post-operatively. Any decrease in blood product administration helps minimize patient's risk of obtaining possible transfusion reactions and side effects. Any reaction as a result of blood product administration can be extremely costly to the patient and the institution. Adding yet another potential cost saving area for the hospital by using the RoTEM®.

In addition to the need of future projects examining a larger sample size within the tested population, studies utilizing the RoTEM® in other patient populations that require larger amounts of blood transfusion such as cardiac and neurological patients should be examined. If future quality projects on the RoTEM® can prove the trend of decreased product usage in these areas, it could potentially lead to an even greater margin of savings to the hospital based on better utilization of the machine. By using electronic health record systems, one machine can be utilized for multiple types of cases because results can be watched in real-time in the operating room with the machine in a different location. As the usage of the machine is increased, the fixed cost associated with each case become smaller and smaller which, in turn, increases the profit margin of each case.

Implications for Nursing Practice and the DNP Essentials

Doctor of Nursing Practice (DNP)- prepared nurses are in the unique position to be the leaders of using technology for the improvement and transformation of care. This technology gives advanced practice nurses an easy and quick way to interpret what is going on with the patient intra-operatively in order to provide the most beneficial care. The usage of this technology can also help decrease the amount of exposure to blood products that patients experience by giving them only the products required, thus helping to decrease complications associated with blood product administration.

The DNP nurse is also in the unique position to be a leader in the development of new policies, procedures, and protocols. They are the clinical experts and have the upper hand in knowing what is and isn’t practical when projects are done in the perioperative environment. This is an important skill that helps to avoid spending money and resources on projects that don’t have as much clinical impact. The DNP is also able to interpret the research findings from more controlled settings and is able to interpret and incorporate the findings into practice, giving them the skills to be the leaders in program and protocol implementation.

Limitations

A limitation of this project is the small sample size. It is not possible to make generalizations about the presence or absence of statistical significance. In order to address this limitation, the data should be collected over a longer time frame in order to include a large sample size. It is also possible that one should look at the volume (mL) of product given to the patient rather than whole units.

Being a retrospective project there are less controls that can be implemented, such as accounting for different anesthesia providers. With the use of different providers there may be alack of consistency in management of blood transfusion based on the device results. The RoTEM® is only as good as the individual interpreting its results. Providers need to be educated on results interpretation and develop a consistent protocol for treatment of different coagulopathies. A protocol will ensure that one individual isn't giving a more costly product like cryoprecipitate for a particular coagulopathy while another is giving more fresh frozen plasma.

Conclusions

Although the findings were not statistically significant, there are some promising trends that should be noted from this project. This project has shown a trend in the amount of blood product exposure patients experience with the utilization of the RoTEM®. It also has highlighted an area of potential cost savings to the institution. Future quality projects and research studies with a larger population size would be beneficial in order to better determine significance and generate generalizable information related to the impact of the RoTEM® on blood product utilization.

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